Application for Letters Patent of

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For:

HYBRID CHANGE OF STATE PROTOCOL FOR CANopen NETWORKS

Customer No.: 23569

HYBRID CHANGE OF STATE PROTOCOL FOR CANOpen NETWORKS

DESCRIPTION

RELATED APPLICATIONS

None.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable.

TECHNICAL FIELD:

This invention relates to CANOpen networks having a master device and at least one discrete I/O device, and more particularly, to a method and apparatus for determining the state of the discrete I/O device.

BACKGROUND OF THE INVENTION:

The CANOpen network is well known. Typically the CANOpen network includes an intelligent master device and a plurality of I/O modules (slave devices) coupled to a serial communications bus. Typically a CANOpen network includes a plurality of analog I/O modules as well as a plurality of discrete (on/off) I/O modules. Current methods for transmitting data from the I/O modules to the master device are either: (1) timed data transmissions from each of the I/O modules to the master device; (2) random, change-of-state transmissions from the I/O modules to the master device any time the state of one of the I/O modules changed; or (3) timed requests from the master device to each of the I/O modules.

In the first two of these methods, it is impossible to insure that the peak volume of the messages will not overload the master device. This can prevent the master device from processing all of the messages, and thus, messages can be missed. While the third method solves the problem of peak loading, it does not insure that the network is operating at its maximum capacity.

The CANOpen network was originally developed for automobiles, where the number of I/O points, and bus length, are known and relatively limited. For this purpose, the CANOpen network, with the above described limitations, operated satisfactorily. However, there has been a desire to utilize CANOpen networks in industrial control, where greater flexibility in the number of I/O modules and bus length are required. In these situations, the above described limitations have proven to be a problem.

The present invention is provided to solve these and other problems.

SUMMARY OF THE INVENTION:

For a CANOpen network including a bus master and an I/O module, each communicatively coupled to a common bus, wherein the I/O module is subject to a state change, it is an object of the invention to provide a method of permitting the bus master to collect state information from the discrete I/O module.

In accordance with the invention, the method comprises sending a state signal from the I/O module to the bus master in response to a state change of the I/O module, sending a trigger signal from the bus master to the I/O module, and sending a state signal from the I/O module to the bus master in response to the trigger signal.

It is contemplated that the network may include a plurality of I/O modules, each communicatively coupled to the common bus, wherein each of the I/O modules is subject to a state change, and that the method comprises sending a state signal from each of the I/O modules to the bus master in response to a state change of the particular I/O module, sending a trigger signal from the bus master to a selected one of the I/O modules, and sending a state signal from the selected I/O module to the bus master in response to the trigger signal.

It is further contemplated that the method comprises configuring a plurality of the I/O modules as a group, sending a state signal from each of the I/O modules to the bus master in response to a state change of the particular I/O module, sending a trigger signal from the bus master to a selected group of the I/O modules, and sending a state signal from each I/O module of the selected group of I/O modules to the bus master in response to the trigger signal. The group of I/O modules may be less than the total plurality of I/O modules.

It is a further object of the invention to provide a CANOpen network comprising a bus master, an I/O module subject to state changes, and a common bus communicatively coupling the bus master and the I/O module, wherein the bus master includes means for sending a trigger signal from the bus master to the I/O module, and the I/O module includes means for sending a state signal to the bus master in response to a state change and means for sending a state signal from the I/O module to the bus master in response to the trigger signal to permit the bus master to collect state information from the I/O module.

It is contemplated that the network comprises a plurality of I/O modules. Each of the I/O modules is communicatively coupled to the common bus. Each of the I/O

modules is subject to a state change and the bus master includes means for sending a trigger to a selected one of the I/O modules. The I/O modules include means for sending a state signal to the bus master in response to a state change and means for sending a state signal from the selected I/O module to the bus master in response to the trigger signal.

It is further contemplated that each of the I/O modules includes means for sending a state signal to the bus master in response to a state change, a plurality of the I/O modules are configured as a group, the bus master includes means for sending a trigger signal from the bus master to a selected group of the I/O modules, and each of the I/O modules in the selected group include means for sending a state signal from each I/O module of the selected group to the bus master in response to the trigger signal. The group of I/O modules is less than the total plurality of I/O modules.

For a CANOpen network including a bus master and an I/O module, each communicatively coupled to a common bus, wherein the I/O module is subject to a state change, it is a further object of the invention to provide a computer readable medium containing program instructions for execution by the bus master to cause the bus master to perform steps for collecting state information from the I/O module.

In accordance with this aspect of the invention, the method comprises sending a state signal from the I/O module to the bus master in response to a state change of the I/O module, sending a trigger signal from the bus master to the I/O module, and collecting a state signal from the I/O module sent by the I/O module in response to the trigger signal.

These and other aspects and attributes of the present invention will be discussed with reference to the following drawings and accompanying specification.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1 is a block diagram of the present invention.

DETAILED DESCRIPTION OF THE INVENTION:

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

A CANOpen network 10 is illustrated in Fig. 1. The network 10 includes a bus master 12. The bus master 12 may be a field bus coupler, a PLC (programmable logic controller) or such other intelligent master device.

The network 10 further includes a plurality of I/O modules 16. The I/O modules may be analog I/O devices 16a, high priority discrete (on/off) I/O modules 16b or low priority discrete (on/off) I/O modules 16c. A bus 20 communicatively couples the bus master 12 and each of the I/O modules 16.

The discrete I/O modules 16b, 16c are subject to state changes. The high priority discrete I/O modules 16b each include software control for placing a change-of-state signal on the bus 20 to be communicated to the bus master 12 in response to a state change of the respective high priority discrete I/O module 16b. Thus only the high priority change-of state signals will be placed on the bus 20, thus minimizing bus traffic.

Each of the I/O modules 16 (analog or discrete) on the bus 20 will also place their respective data on the bus 20 in response to a respective, unique trigger signal. The bus master 12 includes trigger software control 22 for selectively sending a selected trigger signal from the bus master 12 on to the bus 20. The trigger signal is received by a selected one of the of I/O modules 16 (analog or discrete), to poll the selected I/O module 16 for its data. Thus the bus master 12 is able to selectively poll the I/O modules 16, depending upon the relative priority of their data, again minimizing bus traffic.

The bus master 12 issues a trigger signal once it has sufficiently processed incoming messages, so that it is able to receive and process additional messages. This prevents bus overload and insures that all incoming messages, and in particular incoming change-of-state messages from the high priority discrete I/O modules 16b, are received and processed.

Some or all of the I/O modules 16 may be configured as a group, or groups, of I/O modules 16. Accordingly, the group of I/O modules would collectively respond to a group trigger signal.

This configuration allows performance approaching the theoretical maximum for high priority messages, while retaining the deterministic characteristics of a triggered protocol.

In an alternative embodiment, none of the discrete I/O modules 16 independently place a change-of-state signal on the bus 20. Rather, the I/O modules 16 only respond to respective trigger signals.

As with the first embodiment, the bus master 12 issues a trigger signal once it has sufficiently processed incoming messages, so that it is able to receive and process additional messages.

The particular embodiment used in a given situation depends on various factors, such as the quantity of high priority messages and the volume of data flow on the bus 20.

While specific embodiments have been illustrated and described, numerous modifications come to mind without significantly departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying Claims.